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(54) An integrated electronic warehousing and distribution system

(57) A system 1 comprises a routing network 38 which provides dynamic, real-time access to a product data structure 34 and to a product/warehouse structure 36. Addressing of the product/warehouse structure 36 is carried out using a combination address key of the product and warehouse addresses as determined by the routing network 38. The structures 34, 36 provide for an extremely fast response time in tracking of overall quantities and also location of goods in a complex warehousing situation where there are inter warehouse transfers as well as sales to customers. A dynamic array 39 provides for in-line, real-time auxiliary data to allow responses to be made immediately to queries and sale documents to be generated. A switch 31(b) provides for interface communication control. The structure 36 may contain records 37 only for product/warehouse pairs for which a quantity of the product is stored in that particular warehouse, with new records being created dynamically as required.

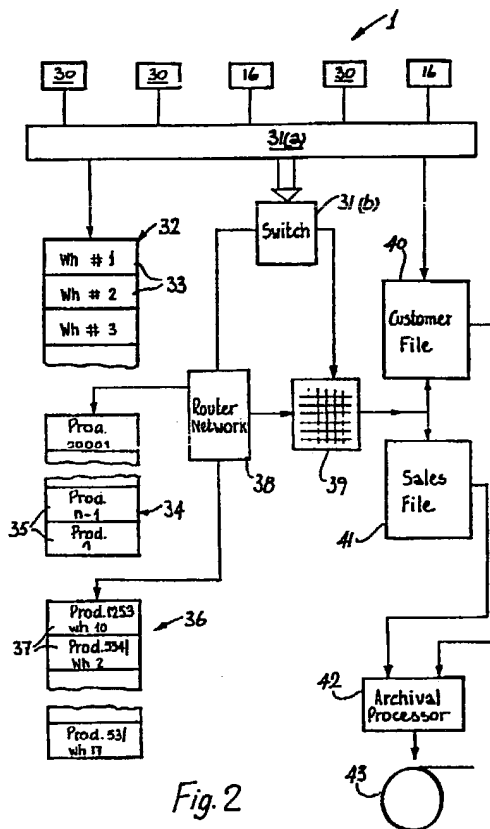


Fig. 2

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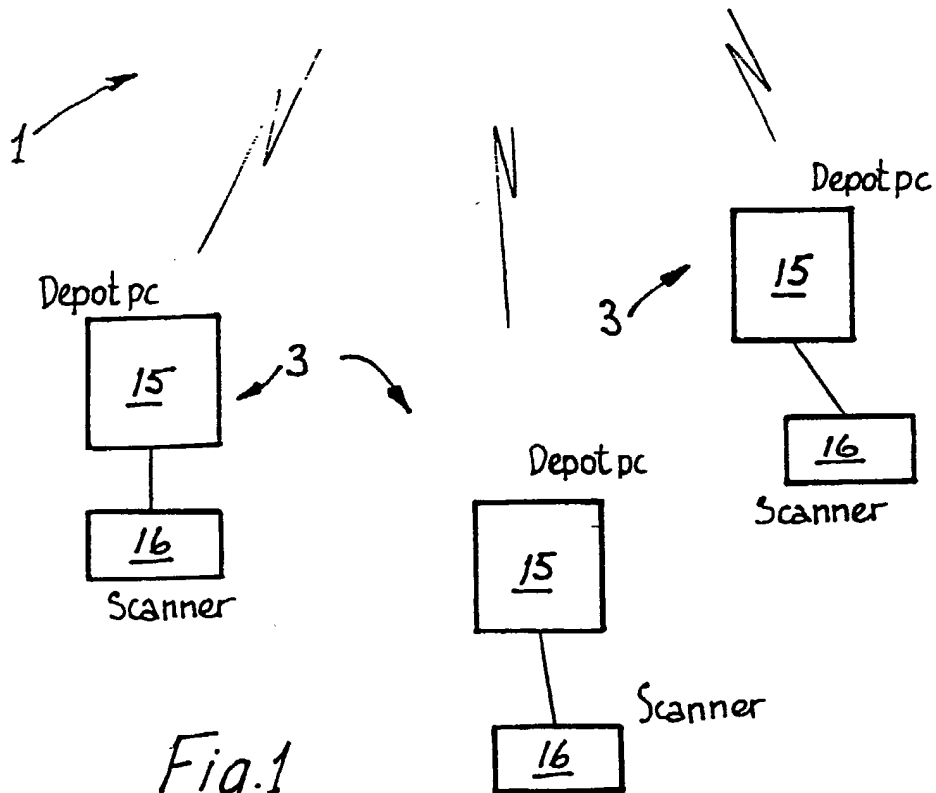
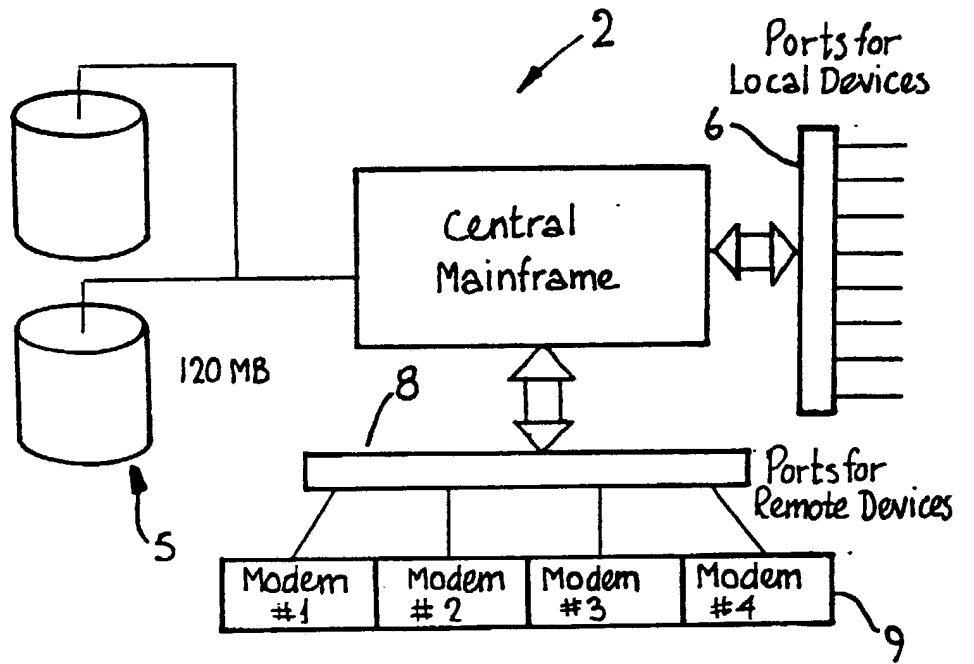


Fig.1

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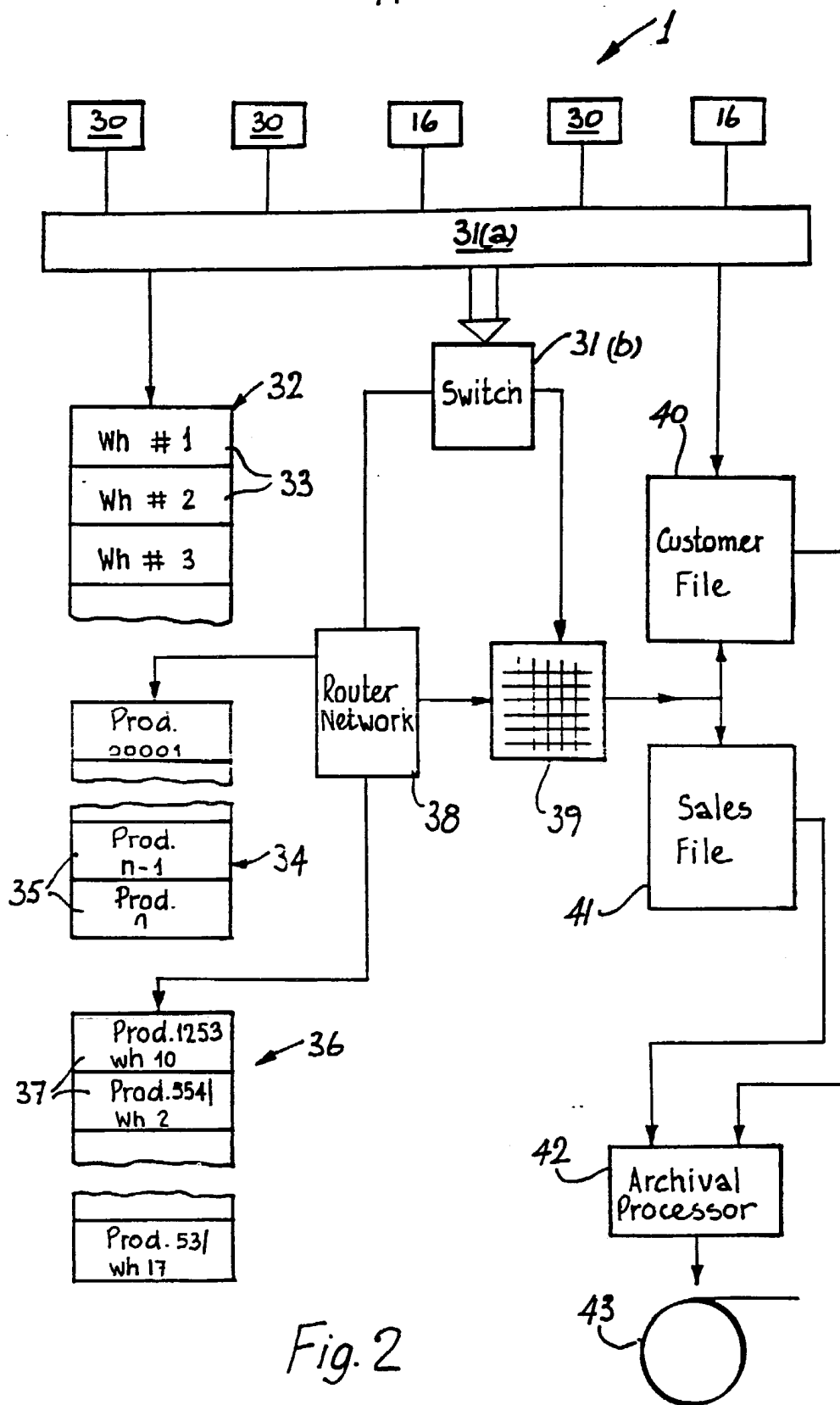


Fig. 2

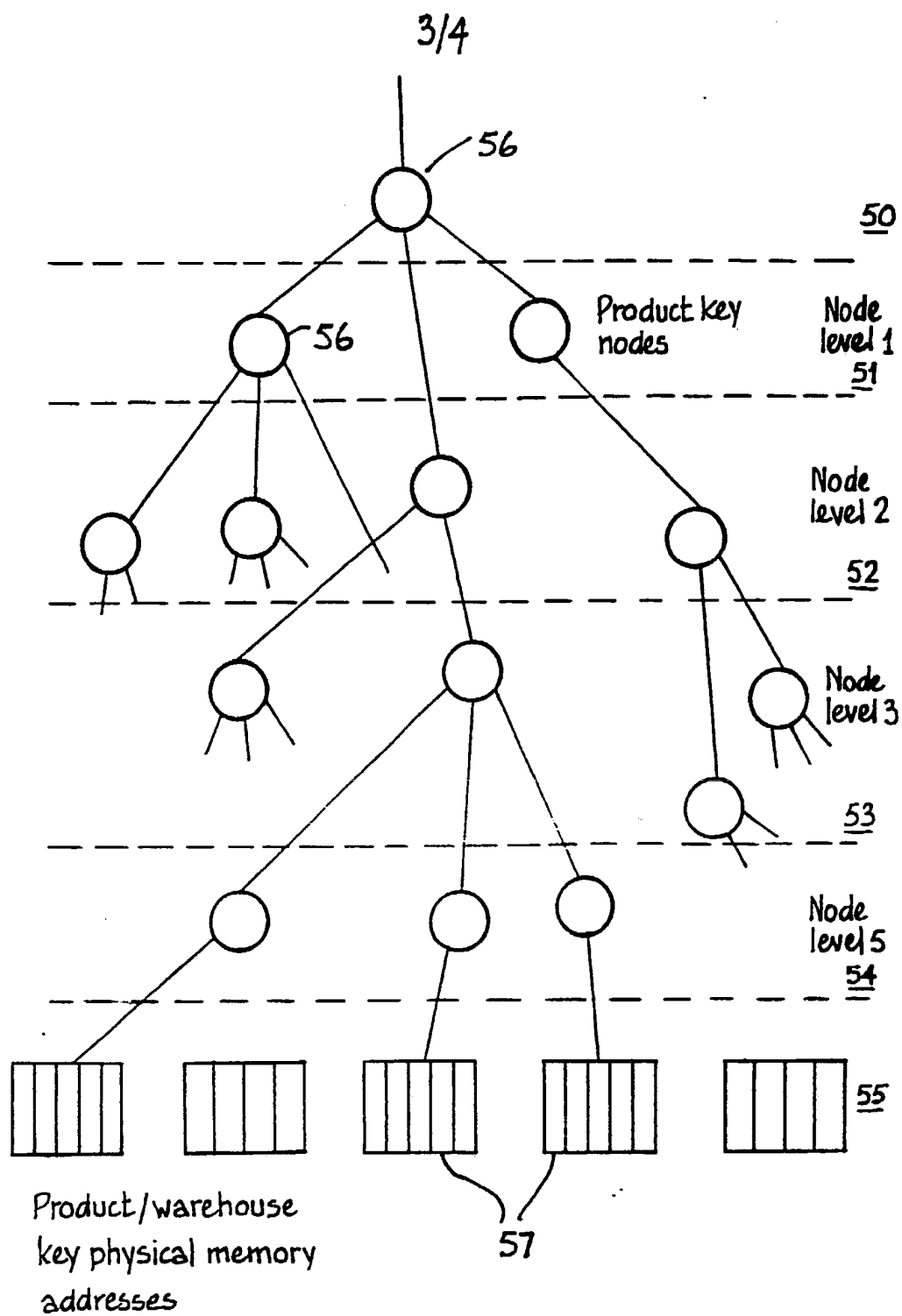


Fig. 3

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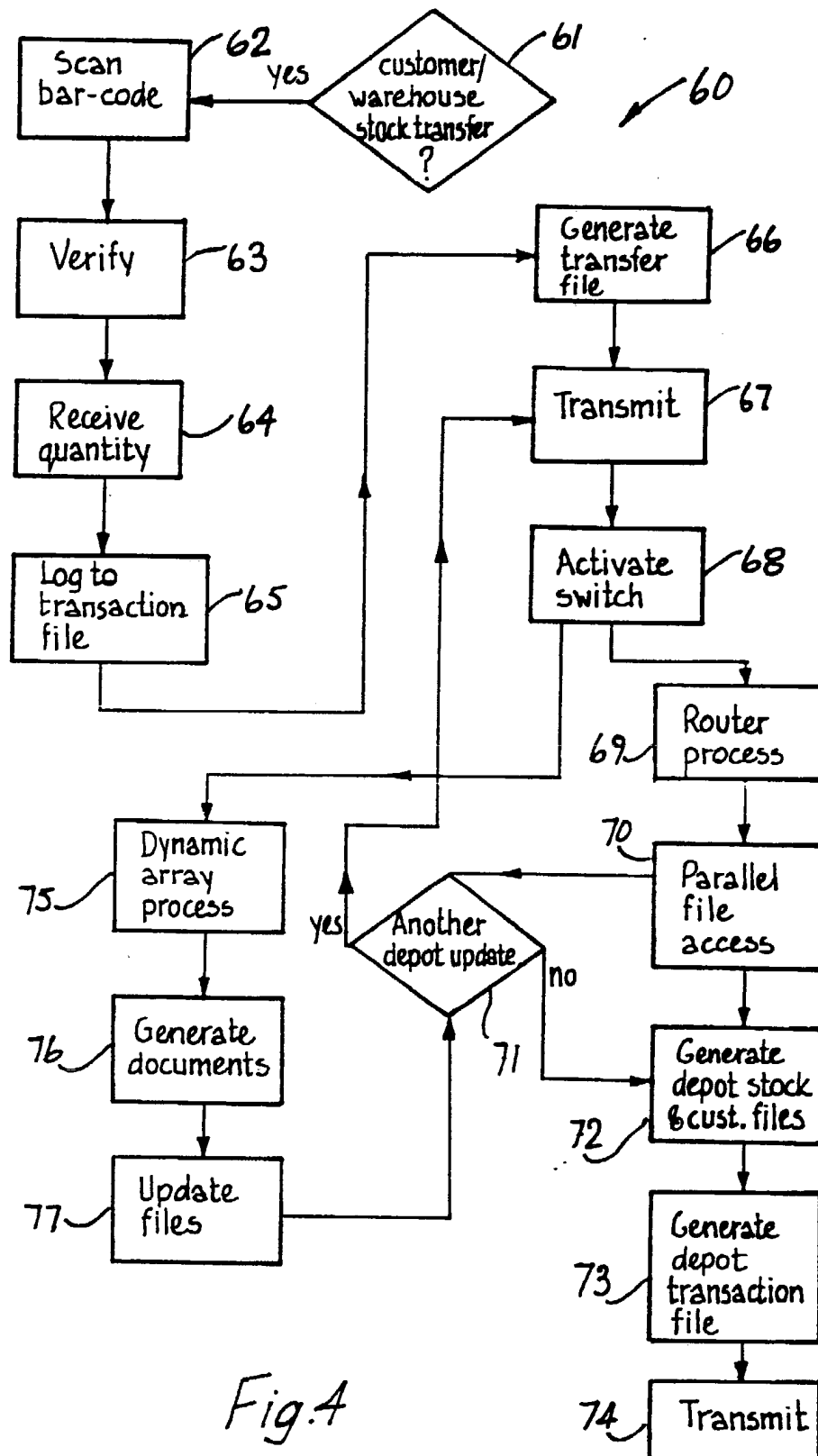


Fig.4

"An integrated electronic warehousing
and distribution system"

The invention relates to an integrated electronic warehousing and distribution system.

Such electronic systems often comprise a warehouse controller which generates output signals to control a retrieval robot, and which also generates various documents including pick-lists and order and invoice documentation.

PCT Patent Specification No. WO 90/11572 describes a system which stores inventory data and various signals are generated such as electronic purchase orders which are transmitted to a central computer. Such a system would appear to be quite effective in certain situations such as that described in the specification. However, presently available systems such as that described in the Specification No. WO 90/11572 are generally not constructed to provide an extremely fast response time by use of technical features underlying the nature of the data. This is particularly true in a complex situation where there are a large number of warehouses and stock transfers between warehouses and sales to customers must be accounted for on a dynamic, real-time basis. The invention is thus directed towards providing the technical steps which are necessary to provide for a very fast response time in a complex warehousing situation so that data inputting and retrieval may be carried out in real time.

British Patent Specification No. GB-B-2194083 describes a state variable processor attached to an input portion for detecting state variables from input data. There is a memory address extraction portion responding to the

detected state variables for control purposes to achieve both sequential control and processing of input data. British Patent Specification No. GB-B-2193017 describes an improved memory access system in which various memory arrays are stored having various features such as a dynamic random access memory having static column access. Address generation, latch, comparator, memory management, and cycle control circuits provide for quick and efficient access to the computer's main memory to obviate the need for separate cache.

The present invention is directed towards providing a system which builds on available technical memory access or data retrieval circuits to provide a very fast response time for real-time operation of an integrated electronic warehousing and distribution system where there are a large number of warehouses with very frequent inventory transfers between warehouses and to customers.

According to the invention, there is provided an integrated electronic warehousing and distribution system comprising:-

- a central data processing system comprising a processor;

- storage devices having a capacity in excess of 100 MB;

- ports connected to reader devices for automatic identification of inventory;

- parts connected to user input/output terminals;

- a bank of communication devices for remote communication;

a plurality of remote processing systems, each associated with an inventory depot, in turn associated with a plurality of inventory warehouses, each depot processing system comprising a reader device for automatic identification of inventory;

a stored product master data structure in which memory locations store data records, each relating to a single stock item, and having an associated address;

a stored product/warehouse data structure in which memory locations store data records, each relating to a particular product and a particular warehouse, wherein each record has an address key which is a combination of the associated product address key and the associated warehouse address key;

a stored warehouse data structure in which memory locations store data records, each relating to a particular warehouse, wherein each record has a warehouse address key;

a routing network comprising a hierarchically interconnected set of nodes, each relating to a set of product address keys, and being located in network levels, nodes of successive levels relating to a smaller set of product address keys, the routing network further comprising a plurality of routing records, each storing physical storage device locations for records of the product/warehouse structure and being accessible via nodes of the routing network;

and a data transfer means comprising means for updating and retrieving inventory level data upon receipt of input data via a port by dynamically determining physical location product/warehouse structure addresses in the routing network in real-time.

In one embodiment, the data transfer means comprises means for accessing the product structure and the product/warehouse structure in parallel for data updates.

In another embodiment, the system further comprises a report generator having two modules, a high-level module having means for accessing the product structure with a product address key, and a low level module having means for accessing in parallel the product and the product/warehouse structures with the combination address key.

Ideally, the physical locations of the product/warehouse structure are occupied by the records out of order with respect to the combination address keys, the order being set by that in which they are created.

In a further embodiment, the system further comprises a dynamic array connected between the ports on one side and customer file and a sales file on the other side, the array dynamically providing additional information during real-time access to said files by the processor, the array being dynamically updatable.

The system may further comprise an archival processor having means for retrieving data from the customer and sales files by by-passing the dynamic array, and for transmitting the data to tape drives.

Preferably, each remote processing system comprises a clock device driving a transfer processor for automatic transmission of inventory data to the central system at periodic intervals.

In one embodiment, the system further comprises a switch device connected between the ports of the central system on one side and the routing network and dynamic array on the other, and comprising means for switching data update signals between the routing network and the dynamic array.

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings in which:-

Fig. 1 is a diagrammatic view showing an integrated electronic warehousing and distribution system of the invention;

Fig. 2 is a diagram showing the various processor and data structures of the system;

Fig. 3 is a diagram showing construction of a routing network of the system; and

Fig. 4 is a flow chart showing operation of the system in more detail.

Referring to the drawings, the system of the invention is indicated generally by the reference numeral 1 and comprises a central data processing system 2 and a number of remote processing systems 3. The system 3 comprises a WANG™ mainframe computer 4 connected to fixed disks 5 having a capacity in excess of 120 MB. Various ports are

connected to the mainframe 4 including ports 6 for connection with local devices along data lines 7, such devices including slave terminals and printers, etc. In addition, there are ports 8 for connection with external devices, primarily the remote systems 3 via a bank of modems 9.

Each remote systems 3 comprises a microcomputer 15 connected to a barcode scanner 16. Equivalent barcode scanners are connected to terminals on the lines 7 and also directly to the internal ports 6 of the central mainframe computer 4. Each of the remote systems 3 relates to a depot which is in turn related to a group of warehouses. An example of such a situation is where very small items such as carbide cutting tips and tools are stored and distributed. Each "warehouse" could be a car or van used by a delivery person, because the items are of very low volume but of very high value. A depot could be a central depot for storage of the items and each warehouse could relate to not only a depot but also to a vehicle. Because of the high value of the items, it is extremely important that location of all of the items be tracked on a real-time, dynamic basis when enquiries are inputted to the system. The invention is directed towards providing the technical features which achieve this end result for control of warehousing and distribution.

Fig. 2 shows the manner in which the processors of the central mainframe 4 and the disks 5 are constructed to provide the necessary technical result. The terminals 30 and the barcode readers 16 are connected to an input interface 31(a). The interface 31(a) provides access to a switch 31(b) which carries out the primary routing of signals. Before describing such routing in detail, the various data structures are now described. One data structure is a warehouse structure 32 comprising a number,

for example, 18, warehouse records 33. Each warehouse record 33 relates to a particular warehouse and the records are grouped in sequential order according to the associated address key. The key of the warehouse may be of any particular type, but is preferably numeric.

There is a product master data structure 34 comprising an ordered set of product records 35 as shown, having address keys 00001 to N. Again, the records 35 are ordered. Each time a new part is handled by the warehouse company, it is assigned a new number incremented from the previous number and a record 35 is added to the structure 34.

There is a product/warehouse data structure 36 in which memory locations store data records 37, each relating to a particular product and a particular warehouse. Each record has an address key which is a combination of the product address key and the associated warehouse address key. The structure 35 is open for accommodation of new records on a continuing basis. For example, when an existing part held by one or more warehouses is transferred to a warehouse which has not previously stored that part, a new record is generated. These records are randomly generated according to the real-time nature of the part transfers. Finally, there is a customer file structure 40 and a sales file structure 41, the former relating to customer data and the latter relating to sales which are generated during specific time periods.

Access to the structures 34 and 36 is via a routing network 38 shown in detail in Fig. 3. The routing network 38 comprises node levels 50, 51, 52, 53 and 54, each comprising one or more nodes 56. Each node 56 stores a sequential group of product address keys, the number per node decreasing for each successive level 50 to 54. There is an additional physical disk locator or routing records

57 in a final level 55. Each record 57 stores the physical locations of records 37 of the product/warehouse structure 36. The addresses which are stored are for those product address keys stored in the final node of the node level 54 connected to it.

The system 2 also includes a dynamic array 39 which is updated regularly in real-time with auxiliary data relating to customer and sales records of the file structures 40 and 41. The array 39 must be accessed on routing of instructions to the file structures from the switch 31(b). There is also an archival processor 42 connected to the customer and sales file structures 40 and 41 on one side, and connected at its output to a tape drive 43.

Referring now to Fig. 4, operation of the system 1 is shown in flowchart format. As indicated by step 61, when a customer or warehouse stock transfer signal is to be generated by a remote system 3, in step 62 the relevant barcode scanner 16 scans the barcode for the particular items of inventory. The identification data which is read in step 62 is automatically verified in step 63 and a quantity for the goods is inputted in step 64 using a keypad. In step 65, the microcomputer 15 of the relevant remote system 3 logs the data to a transaction file. By reference to a clock device, a transfer file is generated in step 66 using the data from the transaction file 65 at half hourly intervals and the transfer file is transmitted in step 67 to the central system 2.

The switch 31(b) is then automatically activated in step 68 and this filters the input signals which are received via the interface 31(a).

There are two possible outputs from the filter of the switch 31(b). One output is where it detects warehouse stock transfers, in which case the signal is routed to the route or network 38 and a routing process is carried out in step 69. This involves the program pointer accessing each node level 50 to 54 in succession according to the product address key which was scanned in step 62. The routing record 57 which is accessed provides the physical location addresses for the records 37 in the structure 36 and this allows parallel access to the structures 34 and 36 to update warehouse data. In this way, the total number of products does not change and so the quantities in each of the product records 35 is not altered, but a flag may be inserted to indicate that there has been a transfer. More importantly, however, the access to the structure 66 changes the relevant record to indicate where exactly the goods are. For example, there may be ten units of a particular carbide tool and five of these may be in one warehouse 5, three in warehouse 9 and one in warehouse 17. Thus, there would be four records 37 accessed in step 70. These steps are repeated if there is another depot updated as indicated by the step 71. In step 72, the data transfer processor, not shown, of the computer 4 generates stock and customer files for the relevant microcomputer 15 of the remote system 3 and in step 73 it generates an empty depot transaction file for use during the processing by the relevant depot system 3. Finally, these files are transmitted in step 74. Steps 72 and 73 are not carried out at regular half hour intervals but in this embodiment are carried out at daily intervals.

If the incoming signal relates to transfer of stock to a customer, the switch 68 provides access both to the router 38 and for the subsequent carrying out of the steps 69 and 70, but also to the dynamic array 39. In this case, up-to-date data is retrieved from the array 39 in step 75 and

subsequently access is made to the files 40 and 41. Using data retrieved from the files 40 and 41 and also from the dynamic array 39, documents are generated in step 76 and the files are updated in step 77. Although not shown in this diagram, outputs are provided via the interface 31(a) to terminals and if required to remote systems 3 showing stock levels. Indeed, the system 1 is constructed so that all of the remote systems 3 store a route or network 38 and at least portion of the product/warehouse file 36 so that they can provide immediate responses showing tracking data relating to the quantities and locations of items in real-time.

The invention provides a combination of a very fast response time for retrieval of data showing not only overall quantities but also precise location in real-time of warehouse products. The documents which are generated in step 76 may relate to high-level management information, in which case access may only be required to the structure 34, thus providing an extremely fast response time. Where more detailed data is required for generation of management information documents, access to both the structures 34 and the structures 36, or alternatively to the structure 36 only may be made. Ideally, the central system 2 comprises separate modules for generation of the separate categories of management information data.

In addition, the system provides for personnel to provide immediate responses to enquiries and also to generate sales and other documentation in real-time. This is because of the on-line access via the dynamic array 39 which allows immediate signalling of problems or of additional data which is of use in real-time. A simple example is where discount levels may vary for different customers, in which case this data may be included in the

array 39 for immediate identification of the appropriate discounts to be given to customers.

An important aspect is that data may be retrieved directly from the file structures 40 and 41 by the archival processor 42 in a manner which by-passes the structures 33, 34 and 35 so that day-to-day processing is not interrupted during this process.

The invention is not limited to the embodiments hereinbefore described, but may be varied in construction and detail.

CLAIMS

1. An integrated electronic warehousing and distribution system comprising:-

5 a central data processing system comprising a processor;

 storage devices having a capacity in excess of 100 MB;

 ports connected to reader devices for automatic identification of inventory;

10 parts connected to user input/output terminals;

 a bank of communication devices for remote communication;

15 a plurality of remote processing systems, each associated with an inventory depot, in turn associated with a plurality of inventory warehouses, each depot processing system comprising a reader device for automatic identification of inventory;

20 a stored product master data structure in which memory locations store data records, each relating to a single stock item, and having an associated address;

25 a stored product/warehouse data structure in which memory locations store data records, each relating to a particular product and a particular warehouse, wherein each record has an address key which is a combination of the associated product address key and the associated warehouse address key;

a stored warehouse data structure in which memory locations store data records, each relating to a particular warehouse, wherein each record has a warehouse address key;

5 a routing network comprising a hierarchically interconnected set of nodes, each relating to a set of product address keys, and being located in network levels, nodes of successive levels relating to a smaller set of product address keys, the routing
10 network further comprising a plurality of routing records, each storing physical storage device locations for records of the product/warehouse structure and being accessible via nodes of the routing network;

15 and a data transfer means comprising means for updating and retrieving inventory level data upon receipt of input data via a port by dynamically determining physical location product/warehouse structure addresses in the routing network in real-
20 time.

2. A system as claimed in claim 1 wherein the data transfer means comprises means for accessing the product structure and the product/warehouse structure in parallel for data updates.

25 3. A system as claimed in claim 2 further comprising a report generator having two modules, a high-level module having means for accessing the product structure with a product address key, and a low level module having means for accessing in parallel the
30 product and the product/warehouse structures with the combination address key.

4. A system as claimed in any of claims 1 to 3 wherein the physical locations of the product/warehouse structure are occupied by the records out of order with respect to the combination address keys, the order being set by that in which they are created.
5
5. A system as claimed in any preceding claim comprising a dynamic array connected between the ports on one side and customer file and a sales file on the other side, the array dynamically providing additional information during real-time access to said files by the processor, the array being dynamically updatable.
10
6. A system as claimed in any preceding claim further comprising an archival processor having means for retrieving data from the customer and sales files by by-passing the dynamic array, and for transmitting the data to tape drives.
15
7. A system as claimed in any preceding claim wherein each remote processing system comprises a clock device driving a transfer processor for automatic transmission of inventory data to the central system at periodic intervals.
20
8. A system as claimed in any preceding claim further comprising a switch device connected between the ports of the central system on one side and the routing network and dynamic array on the other, and comprising means for switching data update signals between the routing network and the dynamic array.
25
9. A system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.
30

15

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(Main Search report)

Application number
GB 9325507.3

Relevant Technical Fields

(i) UK Cl (Ed.M) G4A AUXF, ASX

(ii) Int Cl (Ed.5) G06F 15/24

Search Examiner
PAUL NICHOLLS

Date of completion of Search
3 MARCH 1994

Databases (see below)

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1-9

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